

DOCUMENT RESUME

ED 256 520

PS 015 144

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TITLE The Role of Conceptual Knowledge, Strategy Knowledge, and Specific Mnemonic Context in the Development of Organizational Processes in Memory. Paper 3/1985.
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SPONS AGENCY Volkswagen Foundation, Hanover (West Germany).
PUB DATE Apr 85
NOTE 38p.; Paper presented at the Biennial Meeting of the Society for Research in Child Development (Toronto, Ontario, Canada, April 25-28, 1985).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)
EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Age Differences; *Association (Psychology); *Classification; Cluster Grouping; Cognitive Development; Comparative Analysis; Elementary Education; *Elementary School Students; Grade 2; Grade 4; *Memory; *Metacognition; Recall (Psychology)
IDENTIFIERS Developmental Patterns; *Strategic Behavior

ABSTRACT

The present study investigated the relationship between developmental shifts in the organization of materials and developmental changes in deliberate strategy use. Second- and fourth-grade children were presented with clusterable sort/recall lists representing the factorial combinations of high and low inter-item association and high and low category relatedness. Strategy use in the task was rated by the experimenter and also assessed via self-reports. General and task-related strategy knowledge (metamemory) were also examined. Second graders displayed more category clustering during recall for highly associated items than for weakly associated items, whereas older children showed high sensitivity to both organizational dimensions. Correlations among measures of metamemory and organizational behavior indicated that second graders were generally unaware of the importance of categorization strategies for facilitation of recall. On the other hand, sorting during study and task-related metamemory was found to be the most important predictor of fourth graders' recall performance, thus indicating that most fourth graders use categorization strategies deliberately. (Author/RH)

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The Role of Conceptual Knowledge, Strategy Knowledge,
and Specific Mnemonic Context in the Development of
Organizational Processes in Memory

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This work was supported, in part, by a research grant
from Volkswagen Foundation (AZ II/37 129)

Paper presented at the meetings of the Society for Research
in Child Development, Toronto, 1985

Paper 3/1985

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Abstract

The present study investigated the relationship between developmental shifts in the organization of materials and developmental changes in deliberate strategy use. Second and fourth grade children were presented with clusterable sort/recall lists representing the factorial combinations of high and low inter-item association, and high and low category relatedness. Strategy use in the task was rated by the experimenter and also assessed via self reports. General and task-related strategy knowledge (metamemory) was also examined. Second graders displayed more category clustering during recall for highly associated items than for weakly associated items, whereas older children showed high sensitivity to both organizational dimensions. Correlations among measures of metamemory and organizational behavior indicated that second graders in general were unaware of the importance of categorization strategies for facilitation of recall. On the other hand, sorting during study and task-related metamemory were the most important predictors of fourth graders' recall performance, thus indicating that most fourth graders used categorization strategies deliberately.

The Role of Conceptual Knowledge, Strategy Knowledge,
and Specific Mnemonic Context in the Development of
Organizational Processes in Memory

Over the past ten years, a major focus of memory development research has been the development of organization in children's memory. Age differences indicating older children's superior categorization and subsequent recall performance in free recall- and sort/recall tasks have been attributed to older children's increasing sophistication in the use of organizational strategies, mainly sorting during study and clustering during recall (Lange, 1978; Moely, 1977; Ornstein & Corsale, 1979). According to this viewpoint, organization in recall is the result of strategic processes that represent deliberate and effortful attempts to encode and retrieve information.

More recent research has questioned the validity of this interpretation for various reasons. First, the definition of memory strategies as voluntarily employed is problematic because automatic, unconscious activation defines the use of highly-learned strategies (Naus & Ornstein, 1983; Pressley, Forrest-Pressley, Elliott-Faust, & Miller, in press). Moreover, even if the traditional definition of a memory strategy is applied, there is strong empirical evidence emphasizing the role of the mnemonic context, that is, of situational factors such as the quality of instructions influencing the deployment of mnemonic strategies in free-recall or sort/recall tasks (Corsale and Ornstein, 1980). In addition to instructional effects, characteristics of the to-be-remembered materials have been shown to influence children's ten-

endency to apply memory strategies. In particular, variations of the perceived typicality of the category examples and the degree of associativity among categorically related items have influenced young children's memory behavior. Clustering was observed in kindergarten and young elementary school children when the category structure was made highly salient to them, that is, when either category typicality or associativity among categorically related items was relatively high (see for a review Bjorklund, 1985). This observation, however, does not necessarily mean that categorization during sorting or recall reflects the deliberate utilization of a mnemonic strategy.

Lange (1973, 1978) has argued that young children's clustering during free recall may be automatically determined by the associative structure of the task materials. Two recent studies (Bjorklund & de Marchena, 1984; Frankel & Rollins, in press) presented empirical evidence supporting the position that a developmental shift from memory organization based on associative criteria to memory organization based on taxonomic criteria can be observed during the elementary school years. Bjorklund and de Marchena (1984) demonstrated that older children (fourth- and seventh-graders) organized items according to taxonomic categories and did not use associative relations in their sorts, whereas first grade children showed a tendency toward associative organization when the list structure allowed both associative and categorical organization. Related research includes a study by Frankel and Rollins (in press) who assessed the impact of associative versus categorical relations by factorially manipulating high and low category relatedness and high and low

inter-item associations. They found that fourth and tenth graders showed relatively high levels of organization in recall whenever category relatedness and associative strength was high. In contrast, kindergarteners displayed greater category clustering only for the list compatible with associative organization (i.e., taxonomic factors did not affect performance).

Taken together, these results seem to indicate that younger children's organization during study as well as during recall is guided by automatic associations between items rather than by deliberate category grouping strategies. Consequently, these findings did confirm Lange's (1973, 1978) theoretical claim that relatively automatic associative organization principles mediate young children's recall and output organization. Further, Bjorklund and de Marchena (1984) also provided evidence that young children's clustering during study (in contrast to recall) may be due to automatically activated associative relations. According to the authors, the shift from greater associative organization in first graders to greater categorical organization in fourth and seventh graders does not reflect a shift in the deliberate use of two memory strategies but rather a shift in the ease with which semantic relationships are activated. That is, age changes in memory organization observed through the elementary school years may be attributable primarily to developmental changes in children's semantic memory or knowledge base and not to the emergence of deliberate memory strategies (see also Bjorklund, 1985).

In the present study, an experiment was designed to provide a more thorough test of the role of deliberate memory

strategies in the development of organizational behavior appropriate for solving sort/recall tasks. Second and fourth graders were given a sort/recall task. Four item lists (developed by Frankel and Rollins, in press) were used that factorially manipulated high and low category relatedness in high and low inter-item association. Subjects were instructed to do anything with the items that would help them to remember them better. Three modifications or "enrichments" of the traditional sort/recall task were thought necessary to assess the hypothesis of deliberate strategy usage.

(1) A distinction was made between sorting and studying. Theoretically, enormous recall differences can be expected for subjects who show identical sorting behavior but differ with regard to the way they study the items. Thus, optimal recall performance would be expected for subjects who use more sophisticated study strategies like cumulative rehearsal and self-testing after complete categorization of the items. Thus, both sorting and studying behavior were recorded carefully in the present study.

(2) An attempt was made to assess subject's verbalizable knowledge about memory processes and strategies relevant for the solution of the sort/recall task in question (i.e., task-related metamemory) as well as their knowledge about different aspects of prospective and retrospective memory strategies relevant for memory in school-related and everyday-life contexts (i.e., general metamemory). Because of conceptual and methodological requirements, a multi-method assessment was made in this study (see for a detailed discussion Cavanaugh & Perlmutter, 1982; Schneider, 1984). In addition to an interview similar to that developed by Kreutzer, Leonard, and

Flavell (1975) which tapped general metamemory, and a self-constructed interview dealing with task-related metamemory, children's judgments of strategy effectiveness were assessed via a paired comparison judgment task developed by Justice (1982). Indicators of verbal and nonverbal intelligence were used to control the influence of intelligence and verbal comprehension on metamemory.

(3) Measures of short-term and long-term memory capacity were included to allow for a more accurate estimate of strategy impact on recall (it should be noted that the term "memory capacity" is used in the sense that the measures represent memory functioning most likely astrategic in nature).

Method

Subjects

The subjects were 96 children, 48 each from second and fourth grade. Children were selected from two public elementary schools located in the Rhein-Neckar area near Heidelberg, West Germany. Mean ages were 7 years 11 months, and 10 years 1 month for the second and fourth grade children, respectively.

Design and Materials

Sort-recall task. The present study involved a factorial combination of high and low relatedness between stimulus items and category labels with high and low associations among individual items within each category across the two age groups. Twelve subjects of each grade level were randomly assigned to each of the four experimental conditions.

The stimuli were the four sets of black and white line drawings of common objects used by Frankel and Rollins (in press). Each set consisted of six pictures from each of four categories. The four lists contained the following items:

1. High Category Relatedness-High Inter-item Associations: Animals- dog, cat, horse, cow, pig, mouse; Clothing- jacket, sock, pants, shoe, coat, hat; Vehicles- car, bus, airplane, train, truck, bicycle; Furniture- chair, table, bed, sofa, desk, lamp.

2. High Category Relatedness-Low Inter-item Associations: Animals- tiger, elephant, cow, pig, bear, dog; Clothing- coat, shoe, dress, pants, sweater, tie; Body Parts- hand, stomach, eye, toes, leg, ear; House Parts- window, door, chimney, floor, roof, brick.

3. Low Category Relatedness-High Inter-item Associations: Animals- goat, deer, buffalo, hippopotamus, monkey, lamb; Clothing- belt, shorts, glove, vest, scarf, jacket; Body Parts- ankle, knee, elbow, shoulder, neck, back; House Parts- patio, porch, fence, gate, steps, railing.

4. Low Category Relatedness-Low Inter-item Associations: Animals- beaver, rat, alligator, camel, squirrel, giraffe; Clothing- belt, gloves, scarf, vest, suit, sweater; Vehicles- tractor, wagon, helicopter, tank, sled, rocket; Furniture- refrigerator, stool, rocker, bookcase, stove, bench.

Inter-item association values were derived from the Marshall and Cofer (1970) and Palermo and Jenkins (1964) norms. Category relations were maximized or minimized according to the norms of Battig and Montague (1969).¹

Assessment of metamemory. The metamemory questionnaire

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included eleven subtests which covered the following topics: planful behavior for a future event, recognizing task difficulty, organized memory search for past events, and strategies for remembering. The more general part of the metamemory interview comprised five subtests representing expanded versions of questions from the Kreutzer, Leonard, and Flavell (1975) questionnaire: Preparation Object, Retrieval Event, (two items) and Rote Paraphrase (two items). These questions have been shown to be the most valid and sensitive indicators of metamemory within the Kreutzer et al. questionnaire for children between 6 and 9 years of age (cf. Cavanaugh & Borkowski, 1980; Kurtz & Borkowski, 1984). The general part of the metamemory interview was completed by an item assessing subjects' knowledge about the importance of retrieval cues when memorizing prose materials.

The more task-related part of the metamemory questionnaire consisted of five items all of which required the subjects to compare the difficulty of two word lists either containing clusterable or non-clusterable items. The word lists presented in the five subtests differed with regard to list length and the arrangement of clusterable items within the lists (i.e., blocked or random order). The five subtests were given in a fixed sequence, the more difficult ones (i.e., those tasks including longer word lists and random ordering of clusterable items within the clusterable word list) always preceding those subtasks where the difference between the two word lists in question became more obvious. Thus an attempt was made to build up a unidimensional scale reflecting the strength and flexibility of metamemorial knowledge.

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In order to get additional information about the consistency of subjects' strategy judgments, black and white videotapes were prepared featuring a 7-year-old male model. Videotaped activities were shown from over the model's shoulder in order to minimize cues as to the sex of the model. After a short introductory period, 30 second demonstrations of each of the following four memory strategies were presented: (a) grouping: placing the pictures into a 3 x 4 matrix by category and naming each group of three together, aloud, two times, e.g., zebra, elephant, fox, zebra, elephant, fox; (b) rehearsal: placing the items into a random 3 x 4 matrix and naming each group of three together, aloud, two times, e.g., bus, shoes, hammer, bus, shoes, hammer; (c) naming: labeling the pictures one at a time with no spatial rearrangement; and (d) looking: visually focussing on the pictures one at a time with no spatial rearrangement.

Following the demonstration of the memory strategies, 12 pairs of strategies were presented for paired comparison judgment. The names of the four strategies were written on 3.5 x 7.5-cm cards. Twelve strategy pairs made up of all possible permutations of the four strategies were presented to the subjects. Children were asked to compare the relative efficacy of each strategy with regard to free recall of a picture list. The 12 trials were divided into two blocks of six trials. The two blocks of trials were reversed to provide two stimulus orders for the paired comparison trials. Half of the children at each grade level received each stimulus order. In order to assess the stability of comparison judgments, subjects were finally asked to rank order the four strategies according to their perceived efficacy.

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Measures of intelligence and memory capacity. Two subtests of the Culture Fair Intelligence Test (Castell & Weiss, 1977) were used to assess subjects' nonverbal intelligence. The 'Classification' subtest required children to mark the object or geometric pattern in a row of objects or geometric patterns that does not go together with the other ones. The 'Matrices' subtest consisted of 12 geometric patterns with one part missing in each item. The child was instructed to identify which of five possible answers correctly completed the geometric pattern. Different item sets were used for second and fourth graders. The vocabulary subtest of the General School Achievement Test (Fippinger & Rieder, 1978) containing 19 items was selected to assess children's verbal ability. Each key word was underlined. Subjects selected a word out of the five possible choices that corresponded most closely to the key word. A slightly modified version of the WISC digit span test was used to assess subjects' short-term memory capacity. In addition, a second measure was constructed to test long-term memory capacity. A list of 20 unrelated items (e.g., cake, bell, eye, drum, castle, etc.) was read to the subjects three times. The sequence of items was varied from one trial to the other in order to minimize the effects of strategy use. Children were instructed that they had to reproduce as many items as possible about half an hour later.

Procedure

Each subject participated in two 45-minute sessions. In the first session, subjects were presented with the measures of verbal and nonverbal intelligence and the short-term memory measure. Testing was conducted within the classroom in

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groups of 15 to 20. During the second session, each child was tested individually. Children were told that they would be shown a set of pictures and should try to do anything that would help them remembering the items of the stimulus set. They were then given a metal board with 24 picture cards arranged in a random order. Subjects had to name all pictures, and the experimenter mentioned their categorical relationship. This was done to insure that category knowledge and the use of category knowledge were not confounded. A two minute sorting period was allowed where children were given an opportunity to rearrange items in order to learn them most efficiently. Categorical organization employed by the subject was rated by the examiner according to an ordinal scale from one to four: 1) Child did not change the position of the stimuli; 2) Child moved the materials, but no organization or at least incomplete organization was achieved; 3) After a certain delay, the child started sorting all or almost all stimuli into categories; 4) The child immediately sorted all items into categories. Next, two more minutes were given for studying the items. Children's behavior during sorting and studying was carefully recorded, and subjects' arrangement of picture cards was photographed.

Again, a rating scale from one to four was used to classify subjects' study behavior: 1) No signs of strategic behavior were detectable; 2) Child labeled the items; 3) Child labeled and rehearsed the items column- or rowwise; 4) In addition to behavior scored under 3) child showed signs of self-testing (e.g., closed his or her eyes and showed lip movements). In addition, the subject was asked to describe what (s)he had done in order to learn the items. Children's

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descriptions were compared with the ratings to assess the degree of consistency. Two points were given when the experimenter rating and subject's description did match completely. One point was given when the descriptions differed with regard to one item, and zero points indicated derivations in more than one behavior category. After study, the board with the pictured cards was removed, and recall was requested. Following the sort/recall task, the long-term memory capacity task was given. Subjects were instructed that a list of 20 unrelated words would be read to them three times, and that they should try to remember the items. A recall test was announced for the end of the session (i.e., 30 minutes later). Immediately after the repeated presentation of the word list, subjects were shown the videotapes and were asked to estimate the efficacy of the four memory strategies used by the videotaped model. Perceived efficacy was assessed via paired comparison judgments and a rank-order of the strategies. Next, the metamemory interview was given. At the end of the session, subjects were asked: "We still have to complete one task. Do you know which I mean?" With the exception of two fourth graders, subjects had obviously forgotten about the long-term capacity recall test, which was given next. If the child was not able to remember any item, the two first stimuli of the first trial were presented as retrieval cues. If the child did not output any names for one minute, the session was terminated.

Results

Organization during Study and Recall. The Adjusted Ratio of Clustering (ARC) score (Roenker, Thompson, & Brown, 1971) was used as a measure of both sorting during study and clus-

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tering during recall. This particular measure has been shown to be relatively independent of the absolute level of recall (Murphy, 1979) and thus been proved adequate for the analysis of clustering behavior in developmental research where levels of recall often vary considerably.

Table 1 contains the ARC scores for organization during study and during recall as a function of Grade and Stimulus Condition. These data were analyzed in two Grade (2) x Category Relationship (2) x Inter-Item Association (2) factorial analyses of variance with the two ARC measures as dependent variables. With regard to sorting during study, only a significant effect of Grade, $F(1, 88) = 8.93$, $p < .01$, was found. On average fourth-graders employed more categorical sorting (ARC = .57) than second graders (ARC = .25).

Insert Table 1 about here

With regard to clustering during recall, significant main effects were found for Grade, $F(1, 88) = 14.86$, $p < .01$, and for Inter-Item Associativity, $F(1, 88) = 6.64$, $p < .05$. Again, fourth graders clustered significantly more than second graders (.61 versus .35), and mean clustering scores were significantly higher for lists with high inter-item associativity, compared to lists with low inter-item associations (.57 vs. .39). Furthermore, a significant two-way interaction of Grade and Inter-Item-Association, $F(1, 88) = 5.47$, $p < .05$, was found, indicating that low inter-item association strength had a large negative impact on younger subjects' clustering scores (high associates, $M = .52$ > low associates, $M = .19$, $t(46) = 3.18$, $p < .01$). No significant

effect of inter-item association strength was found for fourth graders (high associates, $M = .62$; low-associates, $M = .60$, $t(46) = 0.18$, n.s.).

Recall and Clustering. The analysis of the recall data yielded a significant effect of grade, $F(1,88) = 12.91$, $p < 0.01$, indicating that fourth graders' mean recall was significantly better than second graders' mean recall (14.46 versus 11.35). Although no other effects proved statistically significant, the effects of Inter-Item Associativity ($F(1,88) = 3.64$, $p < .06$), Category Relationship ($F(1,88) = 3.27$, $p < .08$), and the two-way interaction of Grade and Inter-Item Associativity ($F(1,88) = 2.77$, $p < .10$) approached significance (see Table 1 for a listing of cell means). The findings were similar to those by Frankel and Rollins (in press) in that recall of fourth graders was low only when both category relatedness and associations were minimized. As has been pointed out by Frankel and Rollins (1982, in press), deliberate strategy use might be reflected by significant correlations between clustering during sorting and clustering during recall on the one hand and between clustering and recall on the other hand. Clustering during sorting, collapsed across experimental conditions, was correlated with clustering during recall and recall within each age group. The six correlation coefficients obtained were .41 (Clustering during Study and Recall), .42 (Clustering during Study and Clustering during Recall), .49 (Clustering during Recall and Recall) for second graders and .43 (Clustering during Study and Recall), .53 (Clustering during Study and Clustering during Recall) and .65 (Clustering during Recall and Recall) for fourth graders. All coefficients were statis-

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tically significant. These findings resemble those of Kee and Bell (1981) who emphasized that in their study, organization during recall was no source of developmental differences in free recall learning, whereas organization at study increased with age. On the other hand, our results differ from those obtained by Frankel and Rellins (in press) who found significant intercorrelations only for the oldest age group (i.e. tenth graders).

Assessment of general metamemory and task-specific strategy knowledge. Total scores were computed for both the six items of the general metamemory interview (GENMETA) and five subtests of the task-related or specific metamemory interview (SPEMETA). The maximum scores for GENMETA and SPEMETA were 6 and 5, respectively, with the results of this analysis recorded in Table 2. These metamemory data were analyzed in two Grade (2) x Category Relationship (2) x Inter-Item Association (2) factorial analyses of variance with GENMETA and SPEMETA as dependent variables. In both analyses, only a significant effect of Grade was found ($F(1.92) = 6.94, p < .01$; $F(1.92) = 10.38, p < .01$ for GENMETA and SPEMETA, respectively).

About 60% of the second-graders and 75% of the fourth-graders consistently judged one strategy as superior to the other across the two pair presentations, a level which is sufficiently reliable to warrant a paired comparison analysis (Thurstone, 1927) on the proportion of times each strategy was chosen over every other strategy by the two age groups. The resulting scale values (also recorded in Table 2) reflect the order of the judged strategies along a continuum of judged effectiveness in the sort/recall task. A test for the

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difference between correlated proportions ($p < .05$, corrected for continuity, McNemar, 1969) indicated that although second graders were significantly less likely to choose the labeling strategy than any of the other three strategies, there was no significant preference among the remaining three strategies. In contrast, fourth graders exhibited a marked preference for the repetition and grouping strategies. For the fourth graders, no significant differences between preferences for groupings vs. repeating on the one hand and looking vs. labeling on the other hand were found. Although the ordering of strategies in the paired comparison analysis was the same for both age groups, the magnitude of the differences between the scale values differed considerably across grades.

In addition to the paired comparison analysis, subjects' rank orderings were assessed. Three points were given for the rank order preferred by adults (i.e., Grouping - Repeating - Labeling - Looking). Two points were given for rank orders differing from this "optimal" sequence in one aspect, one point for a sequence that differed in at least two aspects and so on (see Table 2 for the summary statistics on this assessment). As expected, significant age differences ($p < .01$) were found for the rank ordering procedure, indicating that fourth graders' rankings were more similar to the adult order ($\bar{M} = 1.98$) than were second graders' ($\bar{M} = 1.27$), $t(94) = 2.92$, $p < .01$.

Insert Table 2 about here

When the different measures of declarative metamemory (i.e., GENMETA and SPEMETA) and perceived strategy effective-

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ness were intercorrelated, almost no significant correlations could be found for the second-graders (the only exception being the correlation between the individual preference for the grouping strategy and the rank ordering procedure, $r(48) = .60, p < .01$). On the other hand, generally significant but moderate intercorrelations among the metamemory and strategy effectiveness measures were found for the fourth-graders, with correlations ranging from .29 to .33.

The Impact of Metamemory on Clustering and Recall. Intercorrelations among the two declarative metamemory measures (i.e., SPEMETA and GENMETA), measures of organization, and recall were computed separately for the four experimental conditions and the two grades. Results for the two most different item lists, that is, for the High Category Relation/High Inter-Item Association and Low Category Relation/Low Inter-Item Association lists are presented in Table 3.

Insert Table 3 about here

Within each grade, patterns of intercorrelations varied considerably for the two different item lists. In general, higher correlations among strategy measures and recall were obtained for the Low Category Relation/Low Inter-Item Association lists, and these were stronger for the older subjects. The two metamemory components were not significantly related to second-graders' memory organization and recall (irrespective of experimental conditions), but were closely linked to fourth graders' sorting behavior and recall, particularly for the Low Category Relation/Low Inter-Item Association List. With the exception of the Low Category Re-

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lation/Low Inter-Item-Association List (second graders), general metamemory was more closely related to strategy and recall measures for both age groups than the task-related metamemory component, even though the importance of task-related metamemory did increase with age.

Interestingly, the correlations between metamemory, organizational measures, and recall remained significant when the influence of verbal and nonverbal intelligence on metamemory was taken into account. That is, although significant correlation among verbal intelligence, nonverbal intelligence, and declarative metamemory ranging from .31 to .42 were found for the fourth graders in the present study, the metamemory-memory behavior correlations dropped only insignificantly after the impact of intelligence and vocabulary had been partialled out.

The Role of Memory Capacity, Metamemory, and Organization in Predicting Recall. In order to assess the relative impact of metamemory, memory organization, intelligence, and memory capacity (collapsed across experimental conditions) on children's performance in the sort/recall task, multiple regression analyses were run separately for each grade. As can be seen from Table 4, different patterns of results were obtained for the second and fourth graders. Memory capacity and clustering during recall were the best predictors of second graders' recall performance, whereas metamemory and sorting behavior did not significantly contribute to the prediction of recall. In contrast, sorting during study and task-related metamemory were the most important predictors of fourth graders' recall performance. Interestingly, for both second and fourth graders individual differences in nonverbal

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and verbal intelligence were not related to recall. Both regression models explained a large amount of variance in the dependent variable, with multiple R-Squares for second graders and fourth graders of .58 and .66, respectively.

To explore the importance of memory capacity, memory behavior, and metamemory in explaining age differences in recall, an ANCOVA on recall with age group as the independent variable and the two measures of memory capacity, the two ARC-scores reflecting sorting during study and clustering during recall and the two components of metamemory as covariates was conducted.

The main result was that the aforementioned age differences in recall (second graders: $\bar{M} = 11.35$, fourth graders: $\bar{M} = 14.46$, $t(94) = 5.05$, $p < .01$) were eliminated after adjustment was made for the linear effects of the covariates (adjusted means: 12.71 and 13.10 for second and fourth graders, respectively; $t(94) = 0.55$, n.s.). With the exception of general metamemory, all other covariates proved to be important predictors of age differences in recall.

Insert Table 4 about here

The Impact of the Distinction Between Sorting and Studying. Experimenter ratings of subjects' sorting and studying behavior were used to assess the impact of the distinction between children's sorting and studying on subsequent recall. There were strong correlations between rated sorting behavior and the ARC index of sortings in both age

groups, $r(48) = .81, p < .01$ for second graders, $r(48) = .91, p < .01$ for fourth graders. Similarly, experimenter ratings of studying behavior were closely connected to children's self reports concerning their study strategies, $r(48) = .62, p < .01$ for second graders, $r(48) = .55, p < .01$ for fourth graders. Consequently, the rating variables were felt to exhibit sufficient validity to use them in further analyses.

Not surprisingly, it was found that, regardless of age, children with high rating scores in sorting and studying recalled significantly more than the rest of their age group. The mean recall of the more strategic group was 12.85, compared to an average recall of 9.25 for the less strategic group, $t(48) = 3.52, p < .01$ for second graders and 17.00 compared to 12.48, $t(48) = 3.64, p < .01$ for fourth graders. However, the hypothesis that recall would also differ between children with comparable sorting scores but differing learning behaviors was only partially supported by the data. Contrary to expectations, subjects who showed perfect or almost perfect sorting also recalled more than the average child in their age group, with differences in observed study behavior having no significant impact on recall performance. Similarly, fourth graders who did not sort the items performed poorly in recall independent of the rated quality of study behavior. On the other hand, planful study behavior seemed to effect recall performance of second graders with low sorting scores although the mean differences (13.25 versus 10.09) did not prove to be statistically significant.

Discussion

The main purpose of the modifications and enhancements of the traditional sort/recall task in the present study was to provide a more thorough test of the hypothesis that the shift from more associative organization to a more categorical organization in older elementary school children does not reflect a shift in the deliberate use of memory strategies but a shift in the ease with which different semantic relationships are activated (see Bjorklund, 1985). As developmental shifts in memory behavior in sort/recall tasks may not only be attributable to developmental differences in semantic memory but also to qualitative and quantitative differences in children's metamemory (cf. Schneider, 1984), measures of metamemory were also used to assess the role of deliberate strategy use in elementary school children's memory behavior. An explicit category cue for each stimulus item insured that category knowledge and the use of this knowledge were not confounded. Very few second graders (about 12 %) spontaneously sorted the items according to their category relationship, whereas about 60 % of the fourth graders did so.

The results of this study suggest important developmental changes in organizational behavior. Similar to the findings by Frankel and Rollins (in press) and Lange (1973), second graders demonstrated less clustering during recall and poorer recall for stimuli containing weak inter-item associativity. The systematic manipulation of category relatedness and inter-item associations further revealed that category relatedness alone did not facilitate second graders' recall organization, although it did affect their sorting behavior.

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On the other hand, although fourth graders' recall organization was comparably high in all four experimental conditions, their sorting activities as well as their recall were negatively affected when both item typicality and inter-item associativity were low. Again, this pattern of results confirmed the findings by Frankel and Rollins (in press) in that greater flexibility was demonstrated by the older subjects (i.e., fourth graders).

Interestingly, the results reported by Frankel and Rollins for kindergarteners could be generally replicated for the second graders in the present study. Obviously, associative relations play a substantial role in mediating organization in young elementary school children's memory, and there is no evidence suggesting that such associative organization is deliberate. Rather, the findings indicate that young children's clustering during output represents the relatively automatic activation of well-established memory relationships (cf. Bjorklund, 1985; Bjorklund & de Marchena, 1984; Lange, 1978). On the other hand, recall organization and level of recall in fourth graders appear to be more influenced by categorical information than by automatic associative organization principles.

The distinction between sorting the items and studying the items made in the present study also proved useful. Most subjects who sorted the items perfectly according to their category structure also used more effective study strategies like rehearsal and self-testing (five of the six second graders and 21 of the 28 fourth graders did so). Most subjects who did not engage in sorting the items also failed to show any sign of a systematic study strategy (67 % of the

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second graders and 38 % of the fourth graders belonged to this category). Contrary to expectations, few children in either age group were inconsistent in their sorting and studying behavior (e.g., very effective during sorting and ineffective during studying or vice versa. This finding suggests that those children who spontaneously engaged in effective sorting behavior did have some knowledge of the value of the strategy and the relation between the strategy and the purpose of the task, that is, knowledge about the means-goals relationship (Paris, 1978).

The impact of the subjects' concepts about the value of different strategies for the memory task was more directly assessed by relating strategy use and memory performance to different components of metamemory. Interestingly enough, general metamemory was more closely (but nevertheless only moderately) correlated with second graders' strategy use and recall than task-related metamemory, which did not seem to have any impact on young children's memory behavior and performance. Moreover, both components of metamemory appeared to be independent for the younger subjects, and were also not significantly correlated with their judgments concerning the perceived efficacy of memory strategies. This indicates that relevant and stable pre-existing domain-specific strategy knowledge was probably not available to most younger subjects. On the other hand, in the older subjects, the components of metamemory were related, and individual differences in task-related metamemory were important predictors of strategy use and recall, even after the influence of verbal and nonverbal intelligence had been partialled out. Further, task-related metamemory predicted judgments concerning the

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perceived efficacy of memory strategies. As can be seen from the scale values in Table 2, fourth graders judged grouping and repetition strategies much more effective, compared with the labeling and looking strategies. Interestingly, fourth graders in the present study evaluated the efficacy of different memory strategies very similarly to the second graders in Justice's (1982) study, whereas the second graders in the present study judged strategies very similarly to the kindergarteners in Justice's study. This discrepancy may be due to differences in the stimulus materials used in the two studies, particularly the ease with which category relationships were detectable.

To summarize, converging evidence was found to support the claim that second graders are relatively unaware of the importance of categorization strategies for facilitating recall on sort/recall tasks, indicating that output organization (i.e., clustering during recall) is unvoluntarily guided by associations between items rather than by category grouping principles. Generally low and inconsistent metamemory judgements further indicate that deliberate strategy use is typically not found in this age group (this does not mean that the second graders' approach to the task was a "non-deliberate" -- most of them knew that they had to do something in order to remember --; they simply did not know just what to do, or how to do it).

In contrast, fourth graders seem to be in a transitional state concerning the flexible and deliberate use of memory strategies. That is, approximately half of the sample of fourth graders showed systematic and strategic behavior suited to facilitate recall, whereas the remaining subjects

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seemed unaware of task requirements. Although the design of the experiment did not allow us to assess the functional relationship among task-specific metamemory, memory behavior, and performance, the close correlative relationship found among these variables seems to indicate the importance of voluntary strategies in determining recall older children. Thus it appears that developmental shifts in memory behavior in sort/recall tasks are not only attributable to developmental differences in semantic memory (Bjorklund, 1985) but also to qualitative and quantitative differences in children's metamemory (cf. Schneider, 1984).

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Footnotes

1)

Equivalent norms of prototypicality and inter-item associativity do not exist in Germany. As a consequence it is difficult to assess if the American norms apply to German students. Two recent studies by Flammer, Burkhardt, Jann, Reiske, and Stadler (1985) and Mannhaupt (1983) presenting the first empirical typicality norms in German language provided the opportunity to compare the typicality ratings of five of the six item lists used in the present study (i.e., body parts, animals, furniture, vehicles and clothing) with the ratings for corresponding category members generated by Flammer et al. (1985) and Mannhaupt (1983). It turned out that all items defined as highly related to the category by Frankel and Rollins (in press) ranked in the top 25% of category exemplars according to Flammer et al. (1985), and that almost all of the items showing low category relatedness according to Frankel and Rollins also ranked near the bottom of the Flammer et al. norm list (the only exception being the item "jacket" which ranked 10th in the Flammer et al. norm list). Similar results were found for the Mannhaupt category terms. In addition, a procedure similar to that used by Frankel and Rollins (in press) was chosen to validate categories and associations used in the present study. That is, an

independent sample of 25 second graders was selected. When subjects were asked to sort the items, it turned out that all children -- with the exception of two subjects -- were able to correctly group the test materials into categories. As in the Frankel and Rollins study, children were further asked to choose first, second and third choice pairs of highly associated items within each category. It was expected that normed associates should be picked together more often than with other items in the high associate lists and that greater dispersion in pair choices should occur in the weakly associated sets. Similar to the findings by Frankel and Rollins, these expectations could also be confirmed for the German sample. Taken together, these findings encouraged the author to use translations of the Frankel and Rollins list in the present study.

2)

In a preceding pilot study based on 36 second and fourth graders, subject's sorting and study behavior was independently rated by the same two experimenters who also conducted the present study. The overall agreement between the two raters was 82%. All conflicting ratings were resolved by the raters. Interrater reliability could not be assessed in the present study because of technical problems (i.e., defect video equipment).

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Organizational Memory Processes

Table 1

Mean Category Clustering During Sorting and During Recall
as a Function of Grade, Category Relatedness, and Inter-
Item Association (Standard Deviations in Parentheses).

	<u>Sorting</u>		<u>Clustering</u> <u>during Recall</u>		<u>Recall</u>	
	Second Grade	Fourth Grade	Second Grade	Fourth Grade	Second Grade	Fourth Grade
High Category Relation	.32	.67	.66	.69	12.58	17.16
High Inter-Item Association	(.52)	(.44)	(.30)	(.27)	(3.73)	(3.83)
High Category Relation	.32	.41	.14	.61	10.33	14.83
Low Inter-Item Association	(.49)	(.64)	(.23)	(.25)	(4.54)	(3.69)
Low Category Relation	.19	.80	.37	.55	10.92	14.08
High Inter-Item Association	(.57)	(.33)	(.36)	(.32)	(3.18)	(5.21)
Low Category Relation	.18	.39	.25	.59	11.58	11.75
Low Inter-Item Association	(.51)	(.57)	(.45)	(.36)	(4.18)	(5.06)

Table 2

Means and Standard Deviations (in Parentheses) for the Two Metamemory Components, the Rank-Ordering Procedure, and the Scale Values of the Paired Comparison Analysis, Separately for each Grade.

	Grade 2	Grade 4
SPEMETA	2.23 (1.56)	3.25 (1.52)
GENMETA	4.40 (1.23)	4.98 (0.89)
Rank-Ordering of Strategies	1.27 (1.32)	1.98 (1.04)
Grouping	.424	.770
Repeating	.341	.641
Looking	.233	.006
Labeling	.000	.000

Table 3

Intercorrelations Among Measures of Metamemory, Organization (ARC Scores) and Recall for High Category Relation/High Inter-Item Association and Low Category Relation/Low Inter-Item Association List, Separately for Each Grade

(1) Grade 2

	Sorting During Study	Clustering During Recall	Recall	SPEMETA	GENMETA
Sorting During Study	-	.44	.41*	.01	.05
Clustering During Recall	.64	-	.61*	-.56	.31
Recall	.17	.27	-	-.00	.57
SPEMETA	.18	.10	.18	-	-.11
GENMETA	-.22	-.46	.09	.13	-

(2) Grade 4

	Sorting During Study	Clustering During Recall	Recall	SPEMETA	GENMETA
Sorting During Study	-	.66*	.64*	.37	.78*
Clustering During Recall	.41	-	.10	.02	.60*
Recall	.58*	.49	-	.66*	.63*
SPEMETA	.04	-.04	.51	-	-.13
GENMETA	.24	.68*	.60*	.53	-

The lower triangular matrix always represents intercorrelations obtained for the High Category Relation/High Inter-Item Association Lists, and the upper triangular matrix represents those correlations obtained for the Low Category Relation/Low Inter-Item Association List. Asterisks denote correlations at the 5-percent level.

Table 4

Multiple Regression of Metamemory Measures, Organization Measures, and Memory Capacity Measures on Recall, Separately by Grade

(1) Grade 2

Variables	Beta-Value	F-Value	p-Value
Rank Ordering of Strategies	.08	0.47	0.50
SPEMETA	.09	0.57	0.45
GENMETA	.20	2.74	0.11
Sorting during Study	.14	1.25	0.27
Clustering during Recall	.32	6.58 ¹⁾	0.01
Nonverbal Intelligence (CFT)	-.13	1.21	0.28
Vocabulary	.12	1.03	0.32
Short-Term Memory Capacity	.23	4.47*	0.04
Long-Term Memory Capacity	.44	12.69*	0.001

(2) Grade 4

Variables	Beta-Value	F-Value	p-Value
Rank Ordering of Strategies	.16	2.20	0.15
SPEMETA	.29	7.69	0.01
GENMETA	-.04	0.10	0.75
Sorting during Study	.47	14.87*	0.001
Clustering during Recall	.10	0.53	0.47
Nonverbal Intelligence (CFT)	-.01	0.00	0.95
Vocabulary	.02	0.03	0.87
Short-Term Capacity	.21	3.24	0.08
Long-Term Capacity	.18	2.41	0.13

1) Asterisks denote coefficients significant at the 5% - level